MANAGEMENT INFORMATION SERVICE

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USE OF GRAPHS AND CHARTS FOR MANAGEMENT CONTROL AND REPORTING

What types of charts and graphs are useful for management reporting? What low-cost products are available for designing and drawing graphic materials?

Departmental reporting is a vital means of control for the chief administrator, and many cities therefore have adopted some type of formalized administrative reports. The purposes of these reports are: to provide information for the chief administrator to check on progress of projects and results obtained; to make changes, if necessary, in projects under way; to check on the efficiency of departments; and to supply the administrator with information to be passed on to the city council and the public.

In other words, these reports enable the administrator to plan progress of work, appraise performance, improve services, and control costs. The establishment of a reporting system has been discussed in MIS Report No. 117, *Departmental Records and Reporting* (October, 1953), and sample forms for a reporting system are contained in *Monthly Administrative Reports for Cities* (Chicago: The International City Managers' Association, 1950).

Visual relationships often are more clearly grasped and remembered than numeric data. Thus charts and graphs possess certain qualities which are lacking in textual and tabular forms of data presentation. It is the purpose of this report to discuss some of the major types of graphs and charts, to present some examples, and to identify some of the low-cost commercial products available to the nonprofessional in graphic arts.

Chart Construction

The purpose of a chart is to present facts. In order to do this as effectively as possible, the chart should be clear, accurate, and complete. Four major components should be included on all charts (see Figure 1):

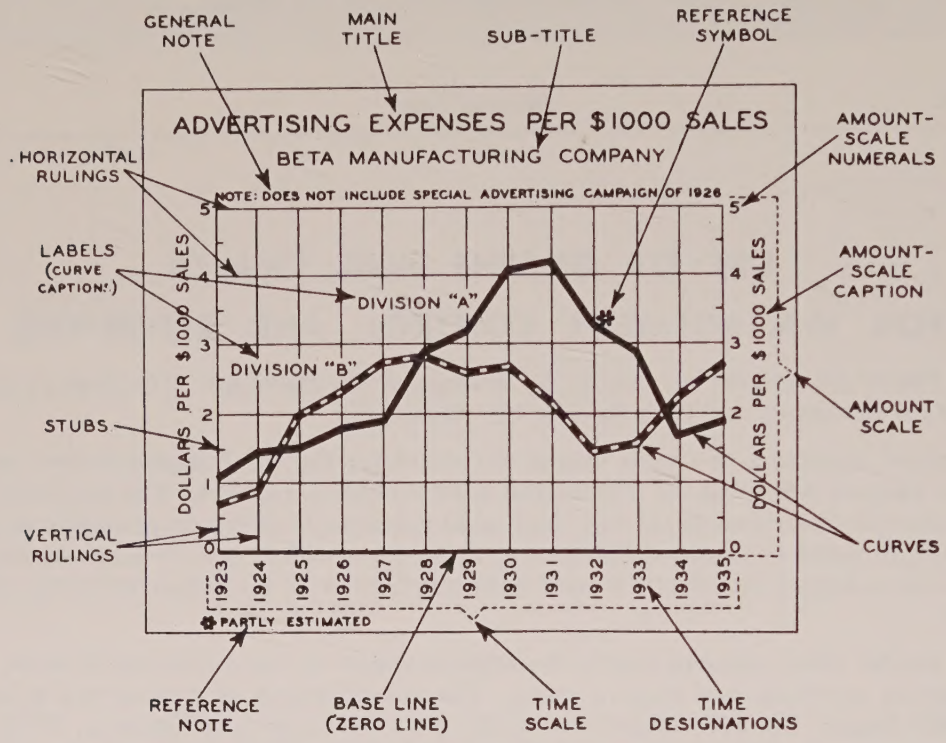
Title. Although it may sound obvious, one part of a chart that too often is omitted is a complete title. Every chart should have a title that is concise and comprehensive, one that indicates the facts that are being presented. If necessary, a subtitle may be added.

Scales. The horizontal scale on a chart runs from left to right, and, in the case of departmental reporting, this scale will usually be a time scale. The vertical scale runs from the bottom to the top, and the amounts or quantities or other data are clearly identified. The importance of proper scale selection and the results obtained by changing the scales are illustrated in Figure 2.

Lines or Rulings. The grid lines or horizontal rulings are those lines that are drawn to aid in plotting and interpretation of the chart. These lines or rulings should be lightly drawn and not too numerous. The reference lines, such as the zero or 100 per cent line, should be emphasized by at least doubling the weight of the line.

Identification of Curves. On graphs where more than one line, curve, or component is used, all of the plotted lines should be identified for reference, either through different types of lines or

DESIGNATION OF CHART COMPONENTS



Source: American Society of Mechanical Engineers, *Time-Series Charts - A Manual of Design and Construction* (New York: American Standards Association, 1938), p. 8.

Figure 1

curves, through the cross-hatch code, or through labels placed directly on the chart. On line charts it is preferable to use a label rather than a key or legend outside the chart.

Types of Charts and Graphs

Many types of charts and graphs are adaptable for municipal departmental reporting. Most of them may be placed into the six following basic categories, or variations thereof.

Since departmental reporting is on a monthly or other time-interval basis, the following charts and graphs (Figures 3-30) generally belong in the over-all category of time-series charts. Data are arranged to show changes that have taken place over a number of time intervals. The horizontal scale will always be a period of time, except for the pie chart, the horizontal bar chart, and the map chart.

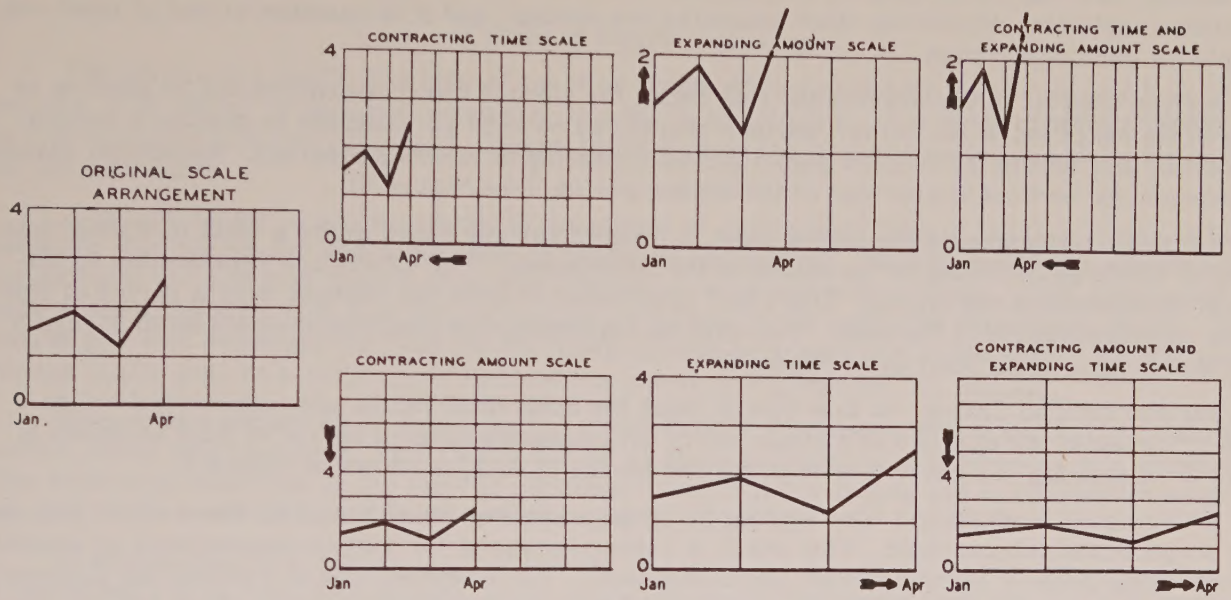
Line Charts. This is the most commonly used and best known of all charts. A line chart is constructed by connecting, in sequence, plotted points with straight lines, forming what is known as a "curve."

The most elementary and thus the most useful form of line chart is one in which the curve is based on a single table of data (see Figure 3). When a comparison of two or three sets of related data is desired, these also may be shown on a line chart (see Figure 4).

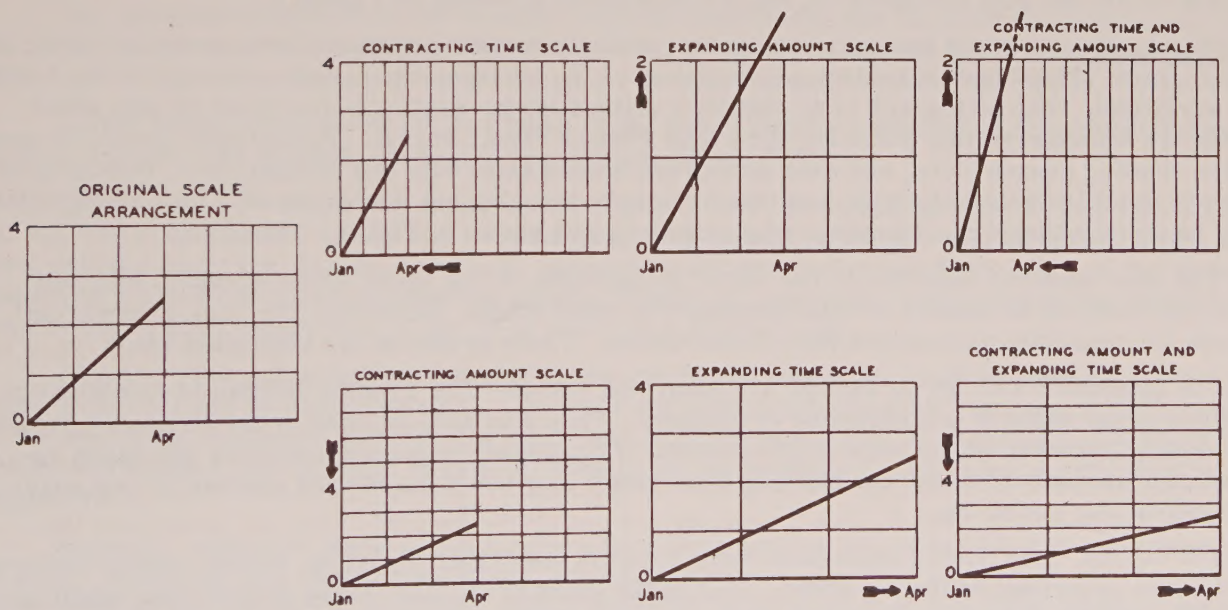
Upon examining these graphs, it is possible to note that their value lies in making it possible to compare quantities, the amount of change as contrasted to the rate of change, the direction of the change, and the time of the change. Their usefulness is readily apparent from an examination of

IMPORTANCE OF PROPER SCALE SELECTION

EFFECT OF SCALE ALTERATION - CHART SHOWING MOVEMENT



EFFECT OF SCALE ALTERATION - CHART SHOWING TREND



Source: American Society of Mechanical Engineers, *Time-Series Charts - A Manual of Design and Construction* (New York: American Standards Association, 1938), p. 36.

Figure 2

the recommended forms for administrative reports. The personnel department may tabulate the number in training or under civil service coverage; the finance department may list unfunded debt or unpaid taxes; the police department may show daily average patrol strength; the fire department may tabulate fire loss index figures; and the public works department may chart the number of public works complaints. Numerous other examples are evident, and it is possible to find at least one example for each department.

Surface Charts. A variation of the line chart, the surface chart is constructed by shading or filling in the space below the curve. Surface charts can be used successfully to present a general picture, but they should not be used where accurate reading of values is desired. Numerical values are indicated by vertical dimensions of the shaded portion (see Figure 5).

A further refinement is the strata chart, a form of surface chart where a total is divided into layers or strata proportional to the values of the components. The values are represented by the vertical dimensions of the layers. This chart is intended to show the changes over a period of time and the component parts of the total. This may be represented in absolute amounts as in Figure 6, or as percentages of the total as in Figure 7.

Bar and Column Charts. In this type of chart the numerical values are represented by the length of the bars. An example of a single set of data compared over a period of time is shown in Figure 8. A grouped bar chart, representing two series of data, is shown in Figure 9.

With respect to showing a time series, the most useful bar chart would be the vertical bar, or more properly the column chart. This chart is especially useful for simple comparisons of amounts and for comparisons of changing totals and components. The simplest type of vertical bar (column) chart is illustrated in Figure 10. Here is one set of data presented over a single time series, providing a simple comparison of amounts. Another major type of vertical bar (column) chart is the component, or subdivided, bar chart. This type of chart is used in the same way as the strata chart described above. Component parts of the total are illustrated in Figure 11, the component parts on the basis of 100 per cent in Figure 12, and a comparative grouping in Figure 13.

Pictographs. A chart that is becoming increasingly popular and more familiar to the public is the pictograph. This chart in reality is a variation of the horizontal bar chart and may be used with many variations. The pictograph is an excellent method for presenting a single set of data since the data are transferred into pictorial ideas with greater visual impact. Pictographs should be used only for showing comparisons, and each pictograph should show only one comparison. Pictographs moreover should only be used with data that are easily translatable into pictures, since pictographs should be self-explanatory. Examples of pictographs are shown in Figures 14 and 15.

The most common objection to the use of pictographs is that many administrators feel that they do not have the necessary artists necessary on their staffs. However, low-cost, commercial products are available to facilitate their construction. These products are discussed below.

The applications of the pictograph are many and varied. The Federal Bureau of Investigation uses them in the uniform classification of offenses. They may also be used in the personnel department to show the relationship between the number of employees under civil service and those appointed on a provisional basis; the building department may use them for the number of new dwellings constructed; and so on.

Pie Charts. The type of chart most often found in municipal reporting, either annual, financial, or budgetary reporting, is the pie chart. This is the chart of circular shape broken into subdivisions with each subdivision indicating the proportion of each component to the whole. This is most commonly used for indicating the sources of revenue and expenditures by major classification. Another use of the pie chart is illustrated in Figure 16.

Map Charts. A type of chart which is useful in depicting relationships among data which are classified on a geographical basis is the map chart. All municipalities have copies of maps showing the political and physical boundaries of the municipality, including street layout. It is this chart that is most useful to the police department in showing the location of accidents; to the fire department in showing the location of major fires (see Figure 17); to the building inspector in showing the location of new construction; and to the public works department in showing the location of public improvements.

The discussion above does not exhaust the variations available, nor does it include all types of charts. However, other charts, such as frequency polygons, semilogarithmic scale line charts, and others of extremely limited application in management control and reporting, are omitted here.

Choice of Charts and Graphs

The choice of a particular type of chart or graph will be guided by the purpose or type of comparison to be made. It becomes necessary to ask: Is the chart to show movements and trends, or is it to compare absolute amounts? Figure 18 illustrates the possible variations of charts based on one set of data.

A second factor to be considered in the choice of a particular type of chart or graph is the audience (the person for whom the chart is prepared and aimed). Most departmental charts will be for internal use and may therefore be more technical in nature and in scope. Also, because of the ease of their construction, line charts may be preferred by the operating department heads. The charts that will eventually be used for the public should be simple and to the point. But the graphs for the public may be a little more elaborate as shown in Figures 19, 20, and 21.

The person preparing or designing the chart should remember that a good chart is clear, accurate, vivid, and complete. One should not try to place too many unrelated items on a single chart. The value of a chart lies in the staying qualities — does it tell a simple and easily remembered story? Is the main idea readily discernible or is it confusing?

It should also be remembered that the use of charts and graphs is not a replacement for, but a supplement to, a reporting system, since there are much meaningful data that are vital to the chief administrator for control and planning that do not readily lend themselves to charting.

Uses of Charts

The material contained in the monthly reports submitted to the chief administrator may readily lend itself to charts and graphs. But some of the information may be better presented in tabular form, and progress on certain projects may best be presented by written description.

Listed below, by department, are some of the items usually contained in an administrative reporting system, and example of possible charts are illustrated.

Personnel. The personnel agency is the logical place for compiling general data on manpower for all city departments. Additions, separations, total number of employees, turnover, extent of civil service coverage, leaves, time lost, injuries, overtime, and training are some of the items generally included in an administrative report. Figure 22 presents a breakdown of the number of employees by department over a period of years in a smaller city.

Finance. The opportunities for charts and graphs derived from financial reports are the ones most often realized by administrators. Receipts and disbursements from the general fund, receipts in various funds, unfunded debt, unpaid taxes, and purchasing all may be readily translated into charts and graphs. An example of expenditures by major budgetary categories is presented in Figure 23.

Planning. Although there is much information contained in the planning department report that is easily converted into charts and graphs, the chief administrator may prefer to limit charts to such items as the number of meetings, public hearings, maps prepared, inquiries handled, subdivision plats, street and alley vacations, and reports on capital improvement program. Figure 24 is an example of the charting of zoning variances, comparing the number of applications submitted with the number granted.

Police. The police department also develops many statistics that lend themselves to graphic presentation: number and disposition of offenses known to the police, analysis of persons charged by the police, juvenile offenders, motor vehicle traffic accidents, distribution of personnel, and daily average patrol strength. Figure 25 is an example of charting the number of convictions as a per cent of total arrests.

Fire. Summary of personnel, fire losses, fire loss index figures, fire prevention, investigation of fires, types of fires, calls other than fires, and the number and how alarms were received may be presented graphically. Major causes of fires over a period of years are presented in Figure 26.

Public Works. Since most of the measured units in municipal reporting are located in the public works department, this is the department that presents the greatest opportunity for cost accounting and charting. Work and cost statements, building permits, inspections, flow and efficiency of the sewage works are but a few of the items readily charted. Of concern to the chief administrator is the number of complaints received by the public works department. This is illustrated in Figure 27.

Recreation. The effectiveness of a recreation department is sometimes appraised by the attendance at various activities. An example of this is shown in Figure 28.

Utilities. Public utilities are another example of activities readily translatable into charts and graphs. An example of water pumped, sold, and lost is presented in Figure 29.

Library. Circulation, reference questions, registration of borrowers, and the book stock are items usually included in the monthly report of the municipal library. An example of the charting of the number of volumes in circulation is presented in Figure 30.

Charting Materials

The basic tools for charting are to be found in any municipal organization, since all that is required is a drafting board, T-square and triangles, the accompanying pencils and pens, and graph paper. However, since the charts should be attractive without using an undue amount of staff time, and may eventually be used for printed reproduction, a number of commercial products are available that facilitate the construction of charts.

Lettering. Although most engineering departments will have lettering guides that are used daily for engineering plans, a number of other products may prove helpful, especially for those charts which will be reproduced in any standard manner.

1. Varigraph (The Varigraph Company, Madison 1, Wisconsin). This instrument is similar to most lettering devices currently in use except for its versatility. With it, it is possible to outline, condense, or extend letters in many sizes using the same template. Templates are available in a wide variety of styles and sizes and may be used for lettering, charting, and the preparation of copy for photographic reproduction. The company also has a variety of inks and a curve attachment.

2. Fototype (Fototype, Incorporated, 1414 Roscoe Street, Chicago 13). Pads of letters used primarily for photographic reproduction. The characters are placed into a special composing stick which automatically aligns and spaces them. The characters are available in over 300 type styles and sizes, and each set comes in its own refillable tray. For each of the sets, it is possible to purchase refills for any particular letter rather than purchasing a complete set when one character is exhausted. Pads of border and symbol sets are also available. (See Figure 31).

3. Die Cut Display Letters (Harry Mich Company, 216 West Ontario Street, Chicago 10). Prefabricated cut-out letters, available in eight styles and colors for use in charts or displays, including cork letters, mystik letters, felt letters, and paper board letters.

4. Redikut Letters (Redikut Letter Company, 185 North Prairie Avenue, Hawthorne, California). Prefabricated cut-out letters and cardboard raised letter alphabets available in nine sizes and 10 standard colors.

Prefabricated Charting Materials. Several products are on the market which provide excellent aids for charts, graphs, maps, and layouts. Most are inexpensive and easy to use. All will reproduce well by various kinds of offset and photoreproduction processes. These products will eliminate or minimize the laborious job of hand drawing lines, screens, cross hatching, dotted patterns, and special symbols.

1. Chart-Pak (Chart-Pak, Incorporated, Leeds, Massachusetts). Producers of an extensive

group of lines, bars, patterns, and symbols commonly used in preparing charts, graphs, maps, and layouts. All are printed on pressure-sensitive, adhesive-backed tapes or sheets. Patterns are available in black on transparent film for use on slides or for transparent overhead projectors; for blueprint or diazo reproduction; and for overlays where material underneath must remain visible. Opaque tapes are printed in black on white background for use on visual presentations, opaque overhead projectors, for photographic reproduction, contact prints, and most standard office copying equipment.

Line tapes (one-eighth inch or narrower) are designed to follow a straightedge, French curve, or geometric patterns, and lie flat and smooth (see Figure 32). In addition to the standard pattern tapes, statistical, graphic, reference, and special symbol tapes are also available. Kits are available for organization and flow charts, graphic components, and office furniture templates. Chart-Pak has a number of pictorial symbols (Pictographs) available in addition to a complete line of accessories.

2. Zip-A-Tone (Para-Tone, Incorporated, 512 West Burlington Avenue, La Grange, Illinois). Designed for applying tonal values in areas of artwork for direct use or for reproduction. Self-adhering mechanical screens, combined with black-and-white artwork or type, may be reproduced by simple line process in the making of photoengravings for letterpress or by "single-shot" line negatives for offset plates with the tonal effect of expensive combination halftones. In addition Zip-A-Tone produces patterns for charts, posters, decorative panels, maps, and other specialized studies as well as alphabets in a wide variety of styles and sizes.

3. Pictograph (Pictograph Corporation, 80 West 40 Street, New York 18). A catalog of 1,000 pictorial symbols. May be used for pictographs, pictorial maps, illustrated bar graphs, and spot illustrations. The corporation is available for consultation on graphic problems of a general nature and will prepare new and individualized symbols, pictographs, and charts to fit special needs. The copyrighted symbols are available on a yearly fee basis.

4. Chart-Typer (Continental Office Machines, Incorporated, 500 Fifth Avenue, New York 36). A typewriter with normal uppercase alphabet and figures, but instead of lower case letters the machine has 27 different chart symbols. The Chart-Typer provides for the typing of many kinds of bar and column chart material. (See Figure 33).

Useful References

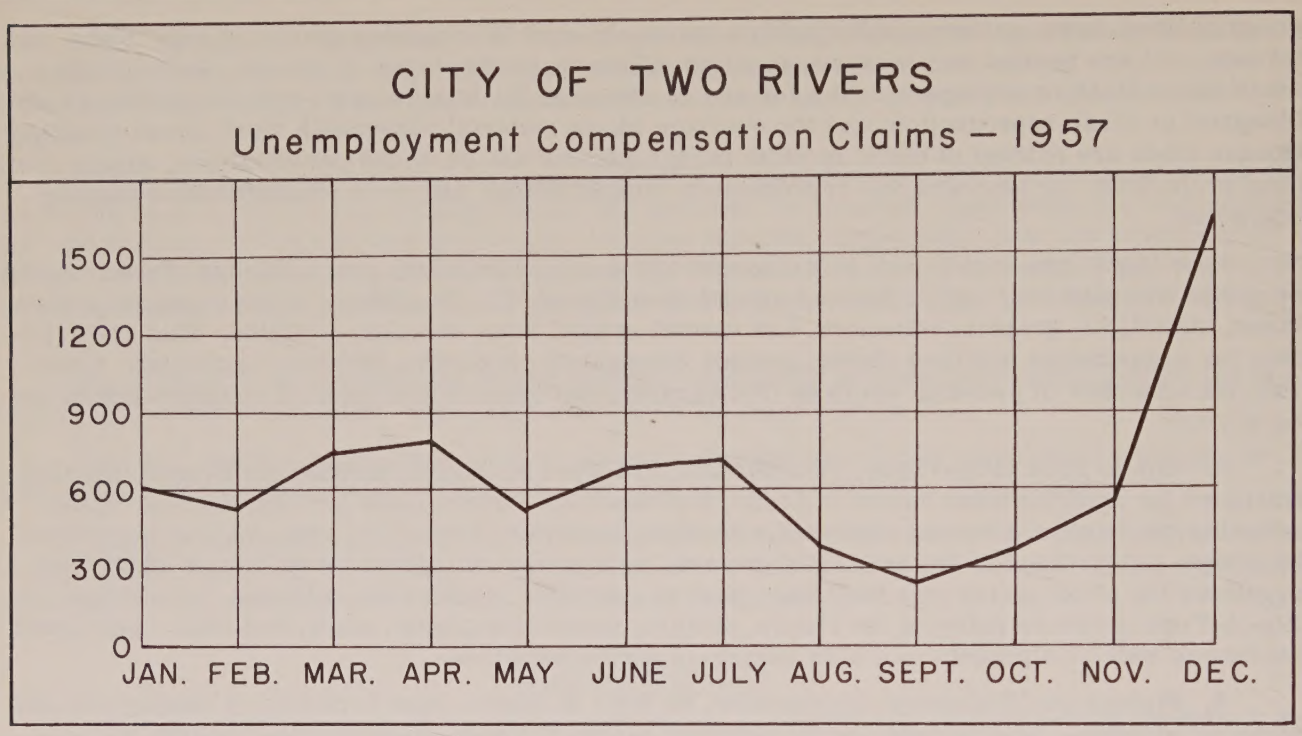
Handbook of Graphic Presentation. By Calvin F. Schmid. The Ronald Press Company, 15 East 26 Street, New York 10. 1954. 316pp. $6. (A detailed discussion of forms of charts and graphs, their construction, and interpretation.)

An Outline of Statistical Methods. By Herbert Arkin and Raymond R. Colton. Barnes and Noble, 105 Fifth Avenue, New York 3. Fourth edition revised, 1950. 224pp. $1.50. (One of the "College Outline Series." Handy statistical reference, with a good section on graphic presentation.)

Pictographs and Graphs. By Rudolf Modley and Dyno Lowenstein. Harper and Brothers, 49 East 33 Street, New York 16. 1952. 186pp. $4. (A discussion of how to make and use pictographs. Contains a number of excellent examples of the effective use of pictographs and graphs.)

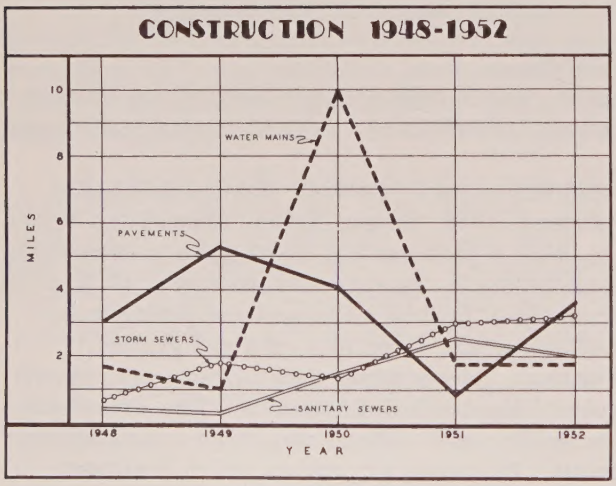
Time-Series Charts — A Manual of Design and Construction. Prepared by Committee on Standards for Graphic Presentation for the American Society of Mechanical Engineers. The American Standards Association, 70 East 45 Street, New York 17. 1938. 68pp. $3. (The construction of time-series charts treated in considerable detail. Prepared for use by chart designers, it is a manual of procedures which have been found successful in the construction of time-series charts.)

Note. This report was prepared by Philip R. Tuhy, staff member, the International City Managers' Association.



Source: Two Rivers, Wisconsin, *Annual Report - 1957*, p. 5.

Figure 3



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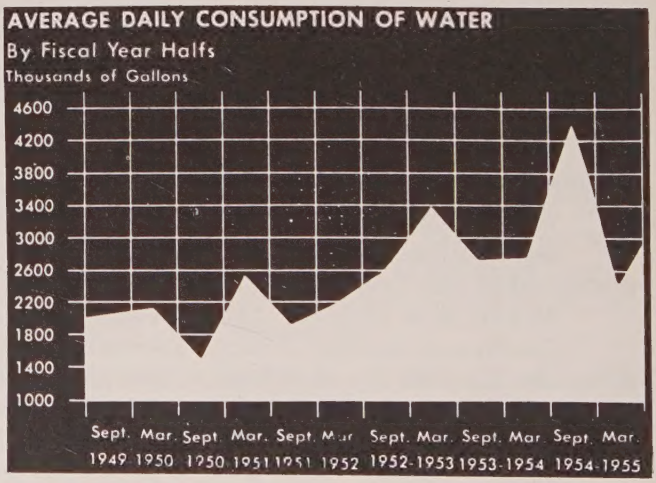
Source: Muskegon, Michigan, *Annual Report - 1952*, p. 23.

Figure 4



Source: Hayward, California, *Annual Report - 1954-1955.*

Figure 5

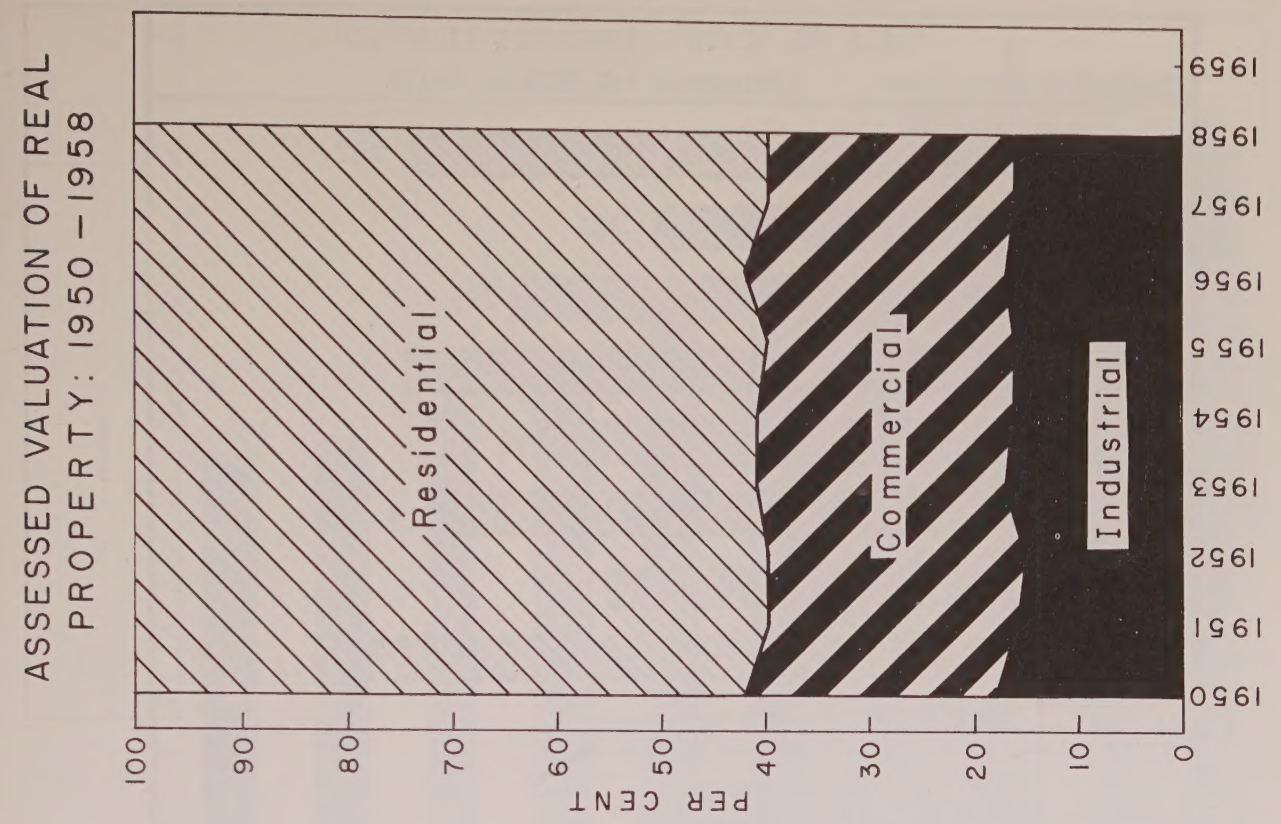


Figure 7

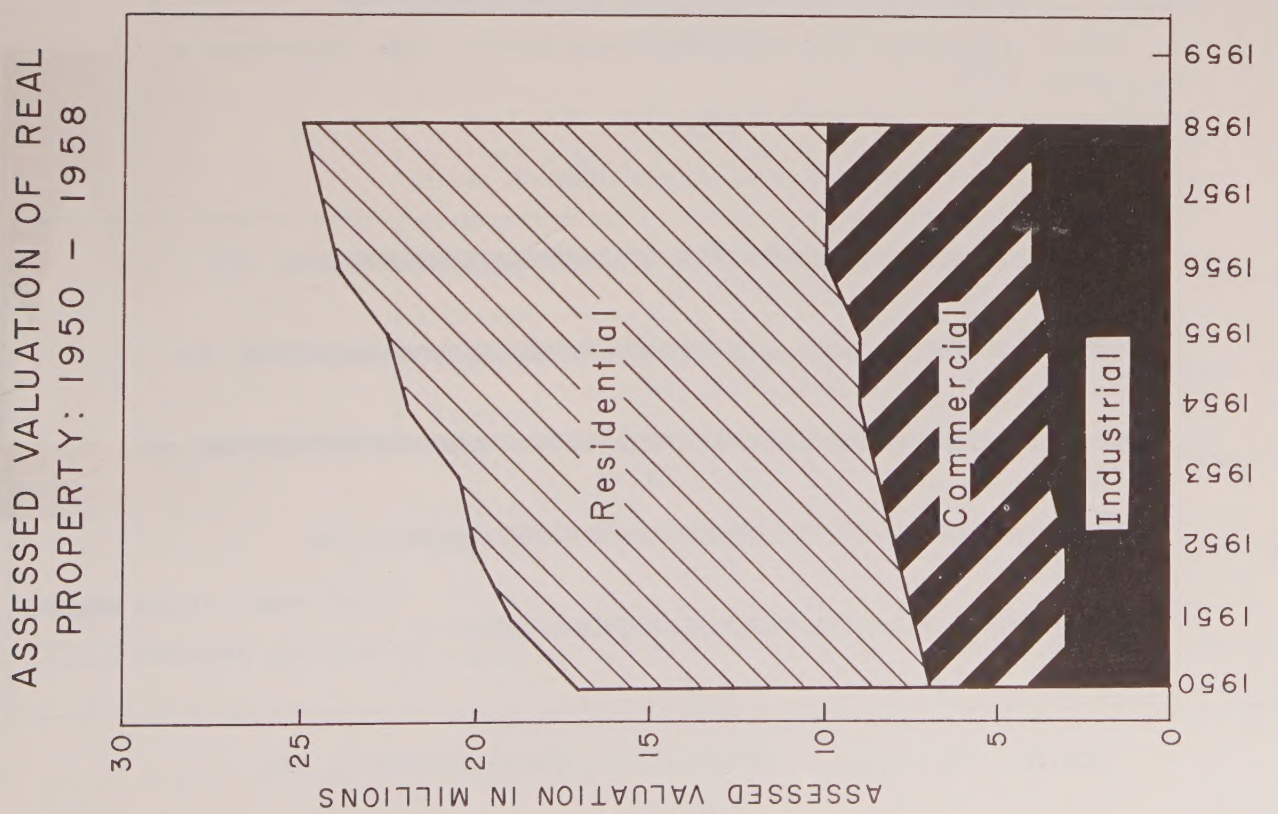
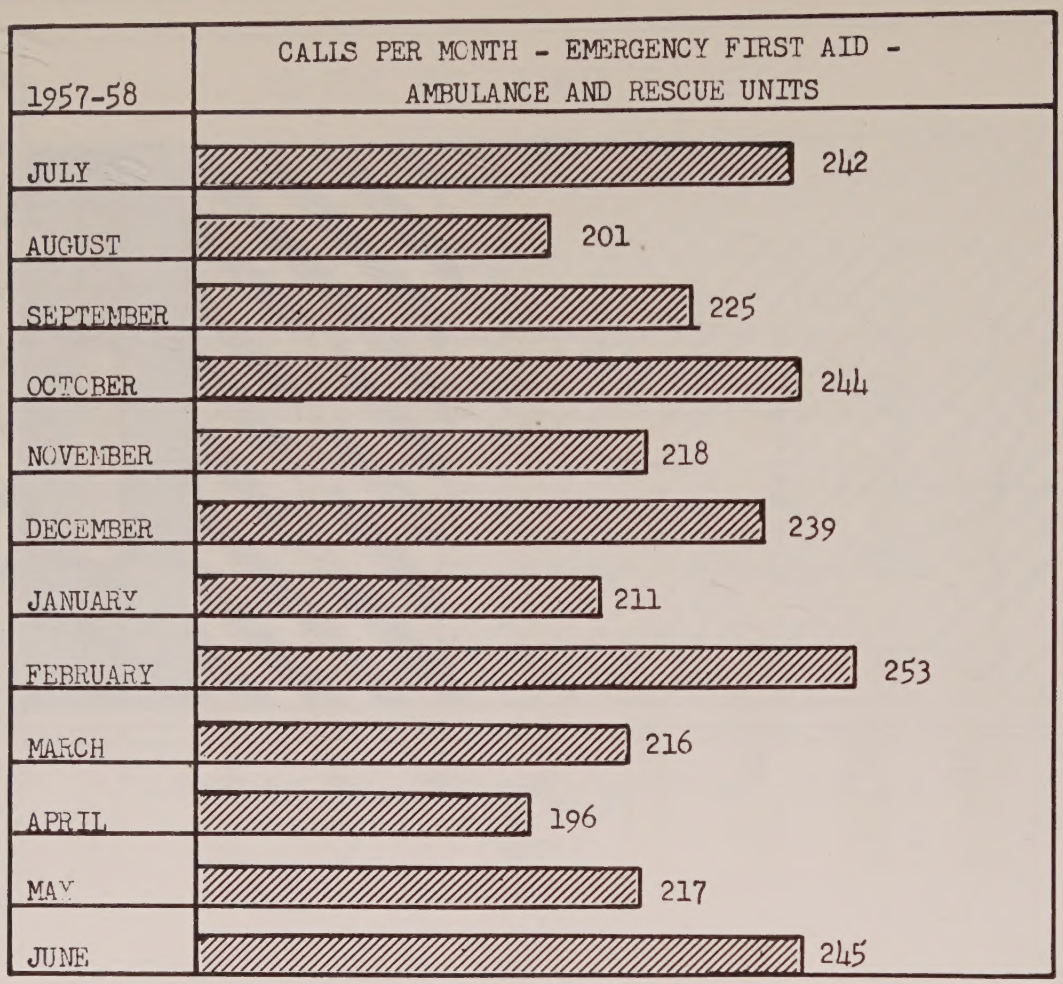


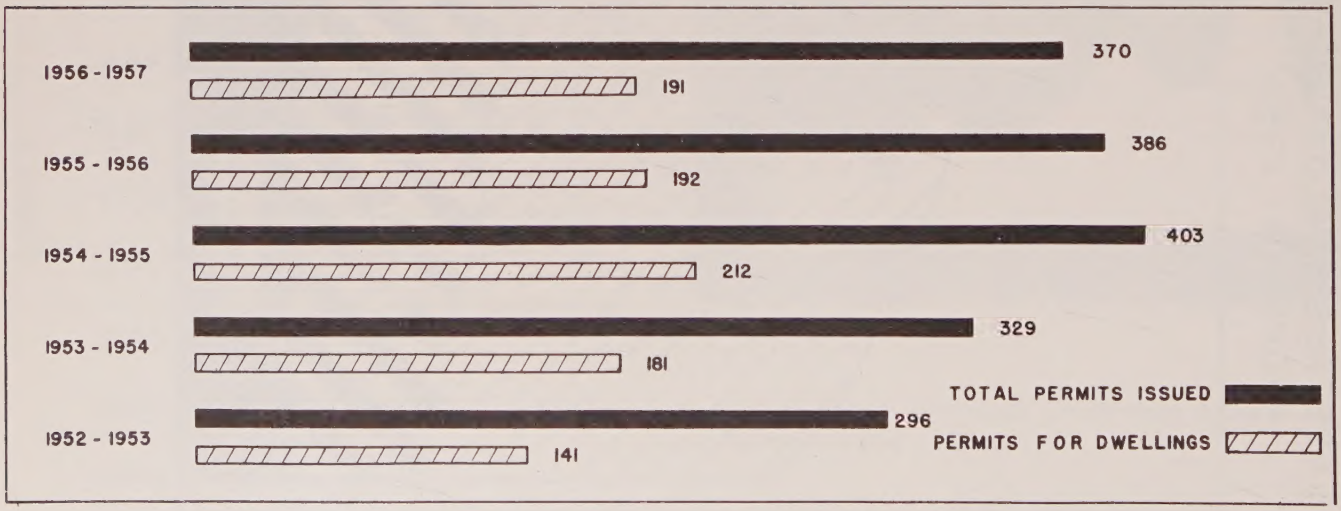
Figure 6



Source: Arlington County, Virginia, *Annual Report - 1958, Department of Public Safety*, p. 20.

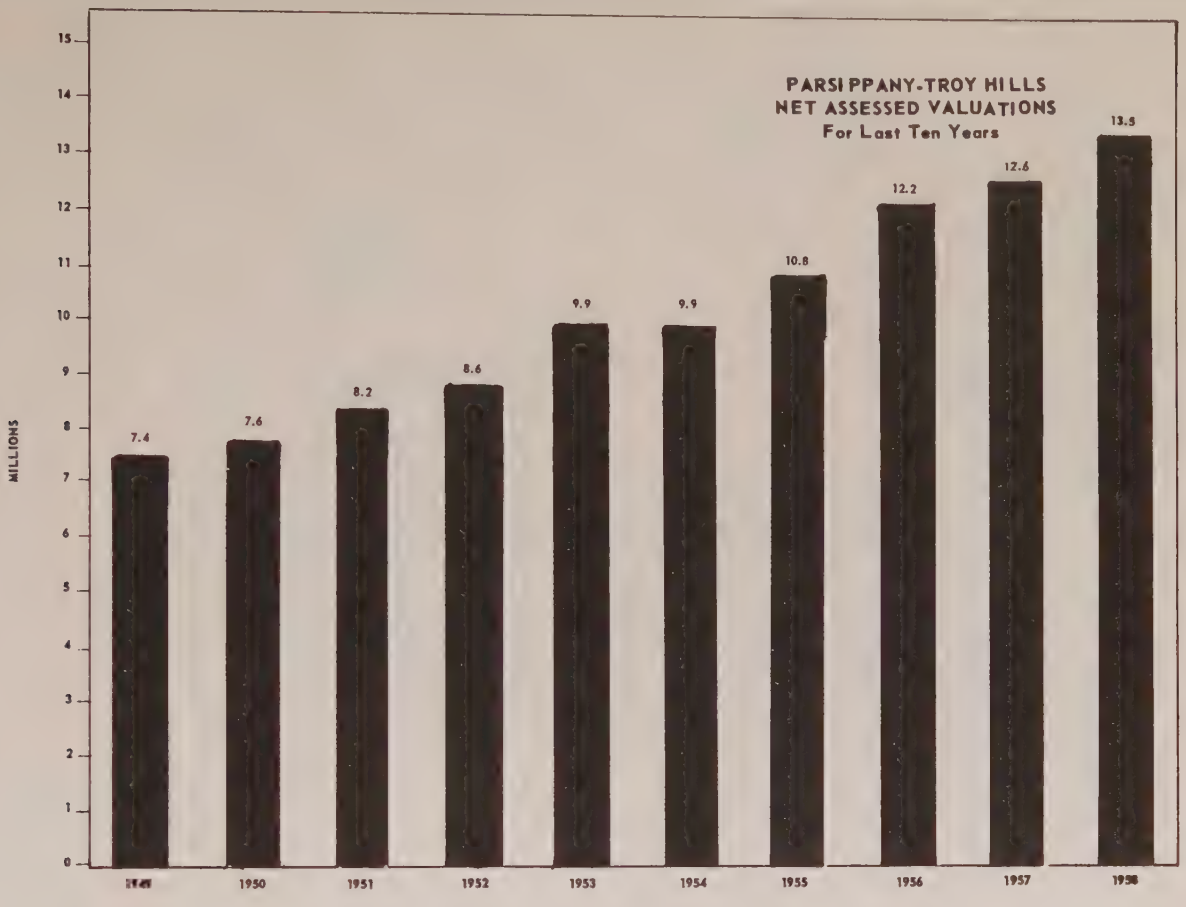
Figure 8

BUILDING PERMITS 1952-1953 THROUGH 1956-1957



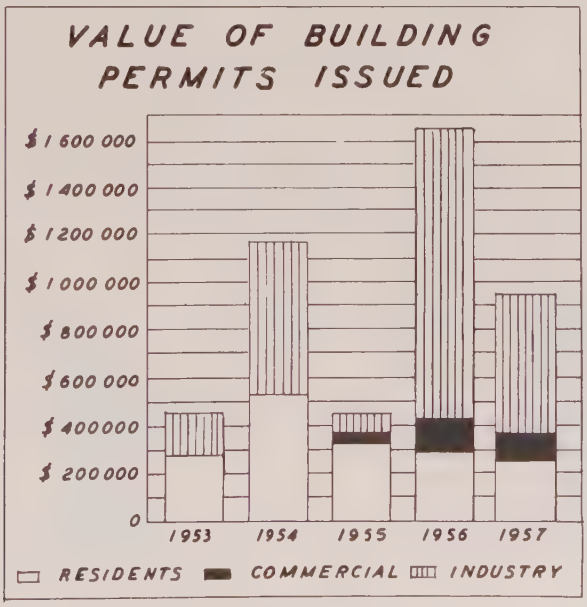
Source: New Canaan, Connecticut, *Annual Report - 1957*, p. 14.

Figure 9



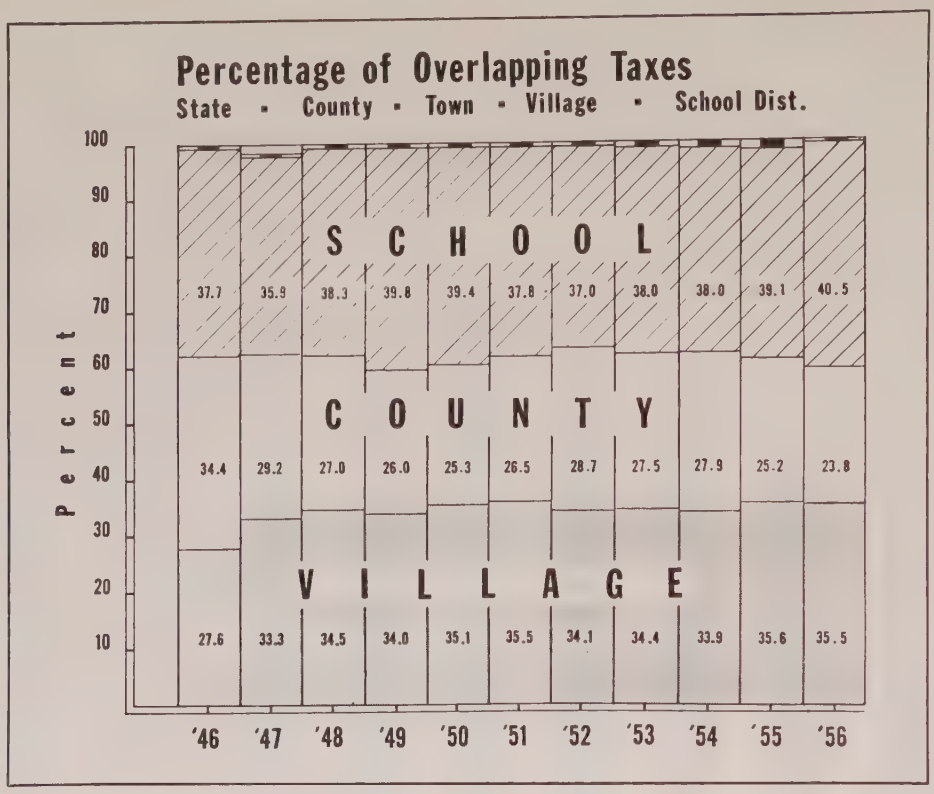
Source: Parsippany-Troy Hills, New Jersey, *Annual Report - 1958*, p. 15.

Figure 10



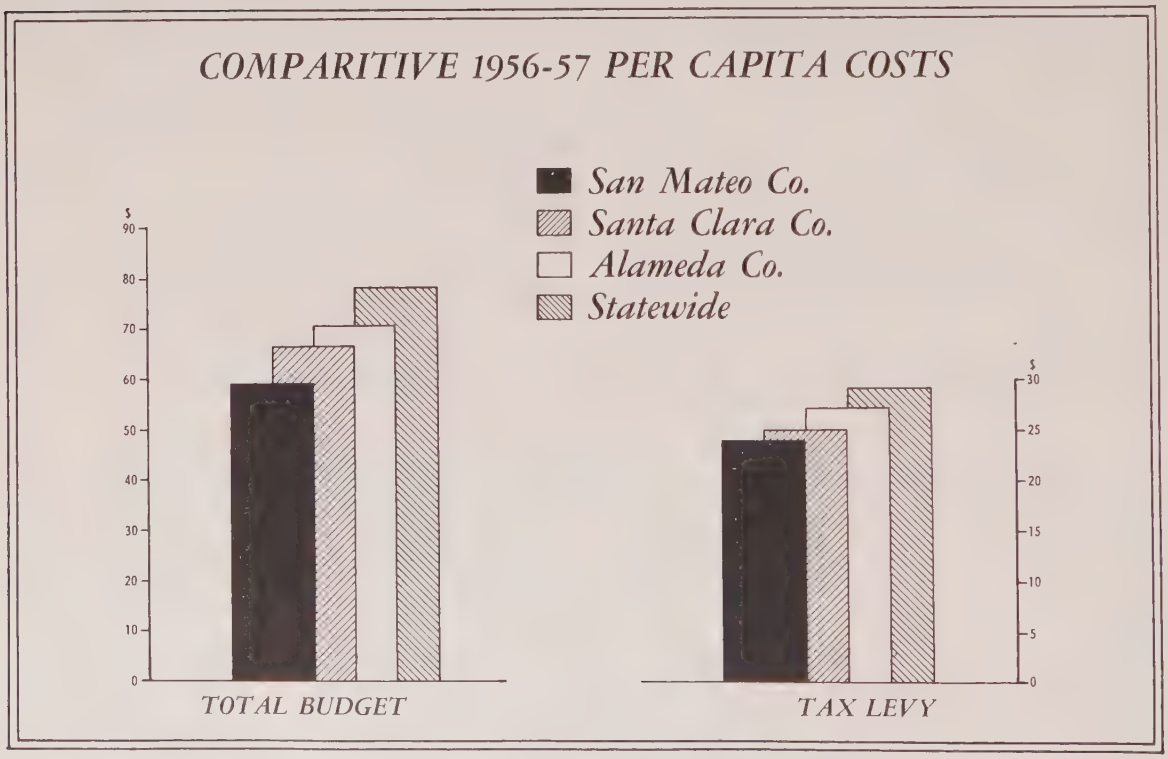
Source: Downingtown, Pennsylvania, *Annual Report - 1957*, p. 11.

Figure 11



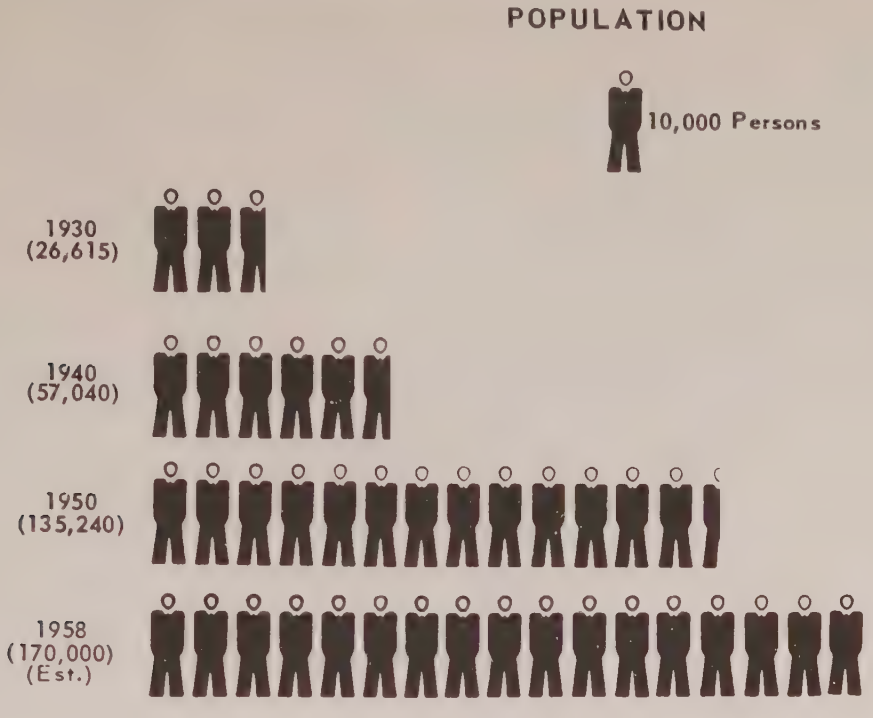
Source: Garden City, New York, *Annual Report - 1956*, p. 45.

Figure 12



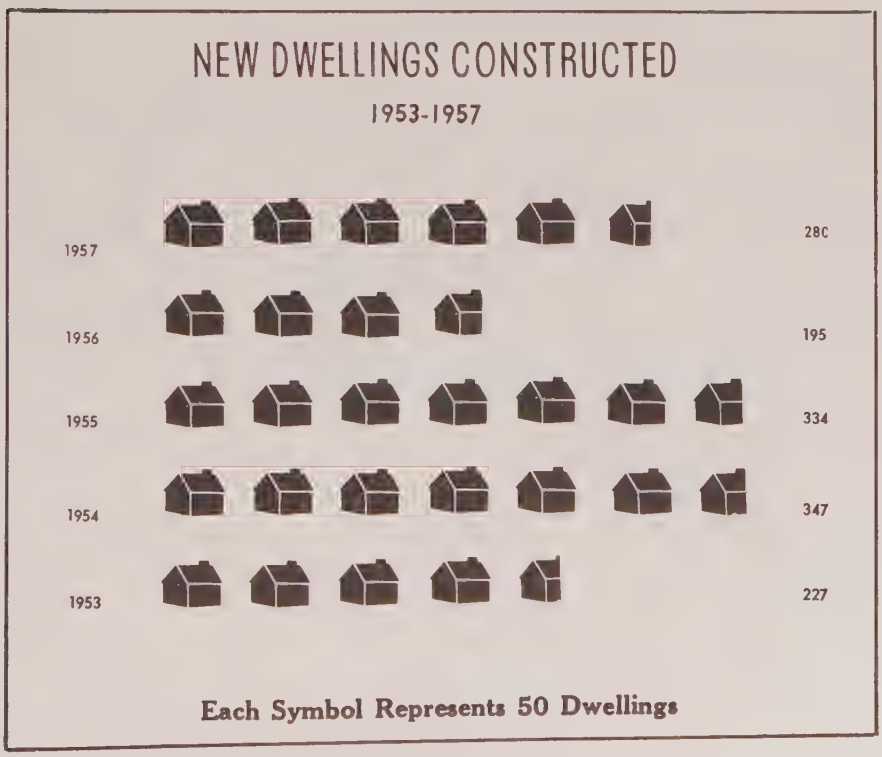
Source: San Mateo County, California, *Annual Report - 1956*, p. 34.

Figure 13



Source: Arlington County, Virginia, *Financial Report - 1958*, p. 49.

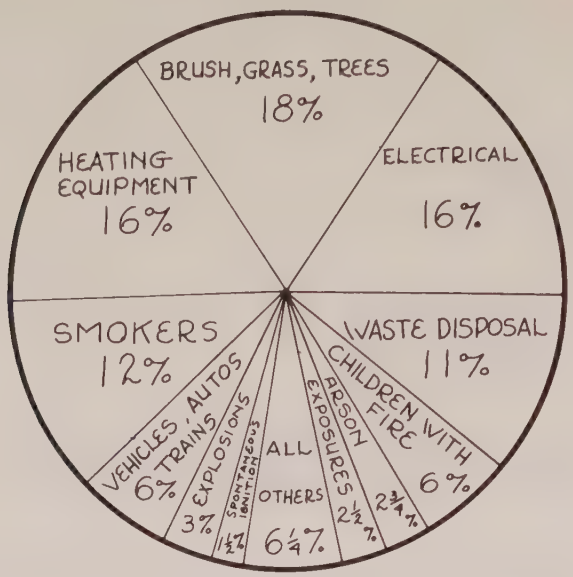
Figure 14



Source: Parsipanny-Troy Hills, New Jersey, *Annual Report - 1958*, p. 21.

Figure 15

CAUSES OF FIRES

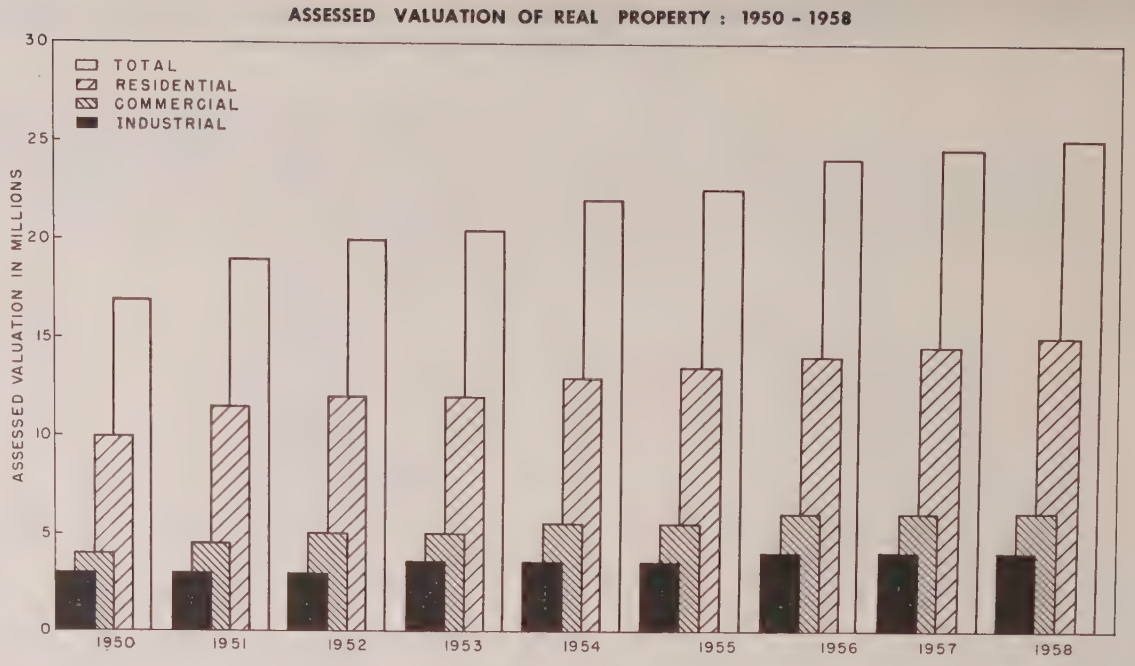


Source: Oakland, California, *Thirty-Seventh Annual Report, Oakland Fire Department*, p. 23.

Figure 16

Source: Oakland, California, *Thirty-Seventh Annual Report, Oakland Fire Department*, p. 19.

Figure 17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RESIDENTIAL
COMMERCIAL
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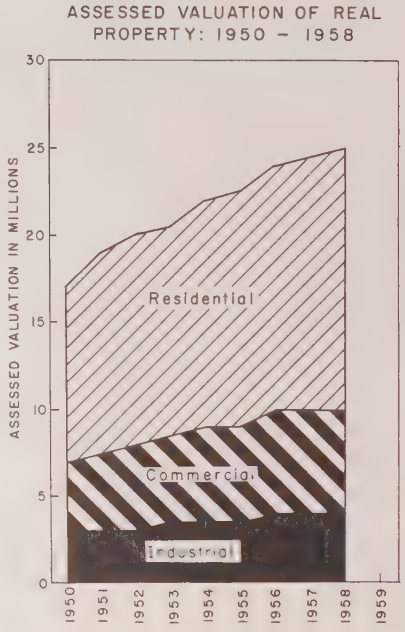
ASSESSED VALUATION OF REAL PROPERTY: 1950 - 1958
ASSESSED VALUATION IN MILLIONS
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Commercial
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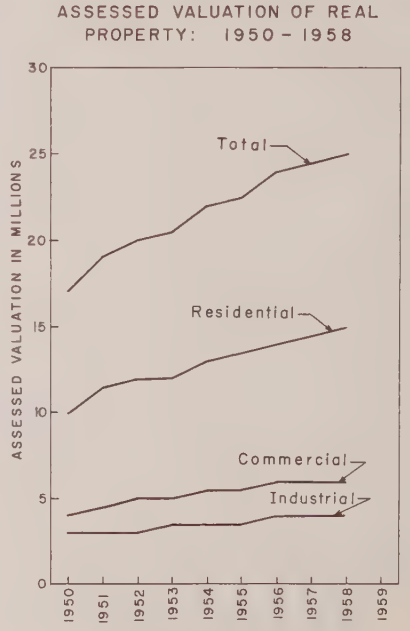
ASSESSED VALUATION OF REAL PROPERTY: 1950 - 1958
ASSESSED VALUATION IN MILLIONS
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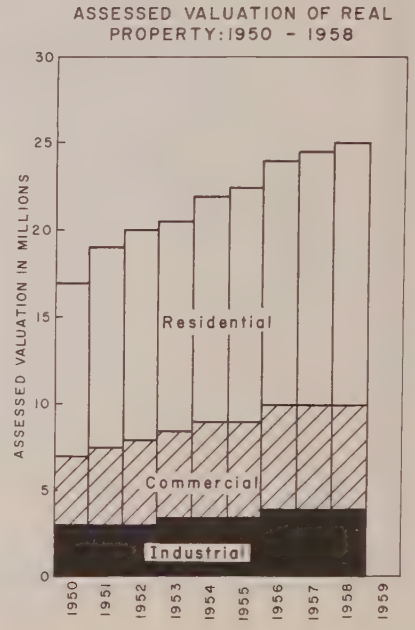
ASSESSED VALUATION OF REAL PROPERTY:1950 - 1958
ASSESSED VALUATION IN MILLIONS
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Commercial
Industrial
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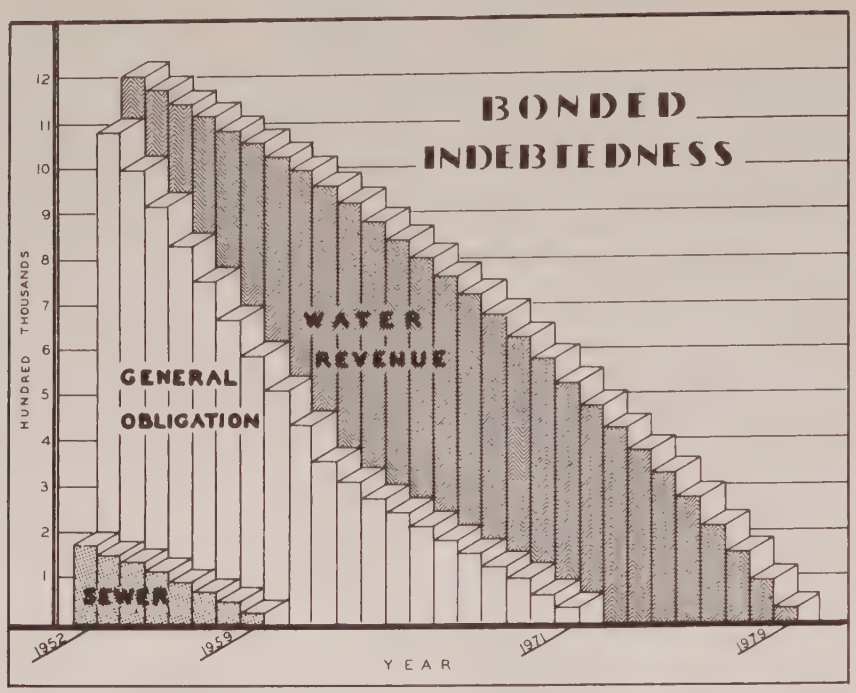
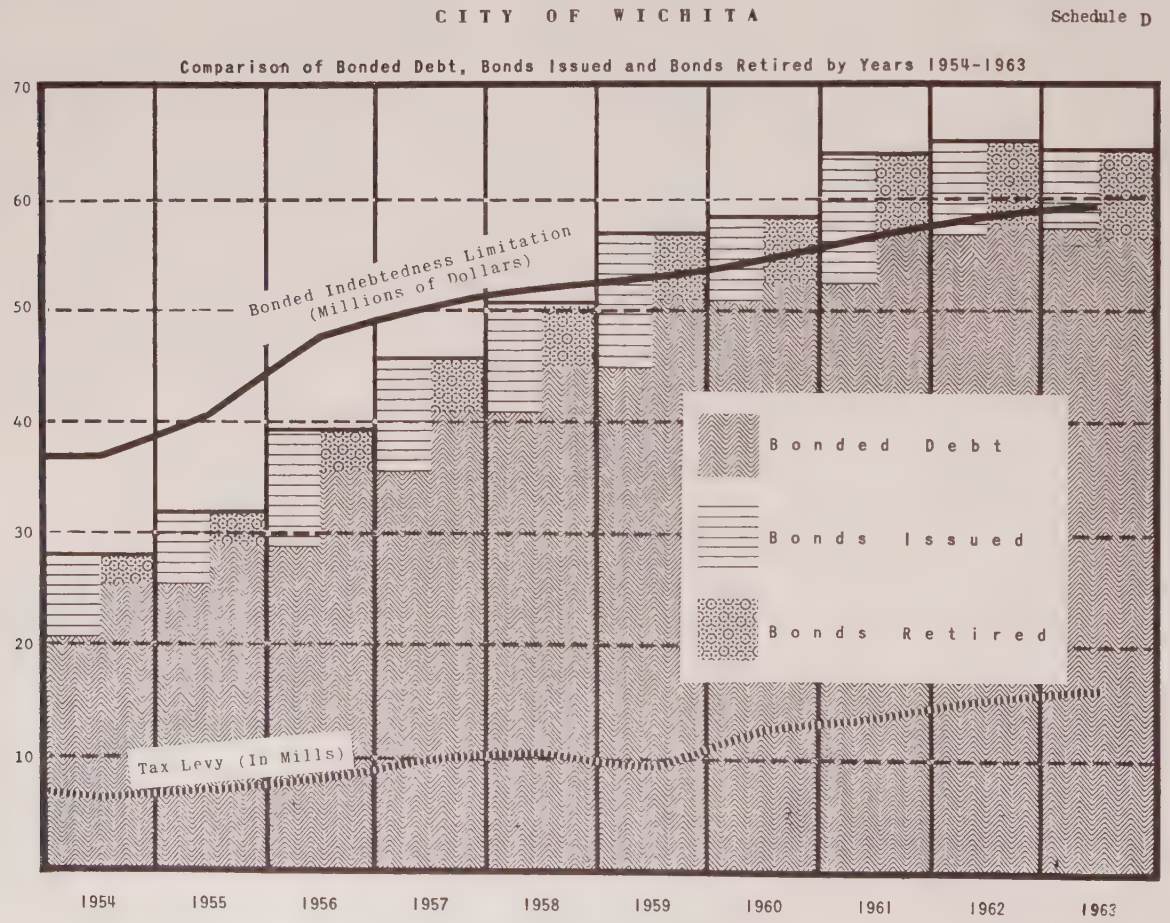
Figure 18



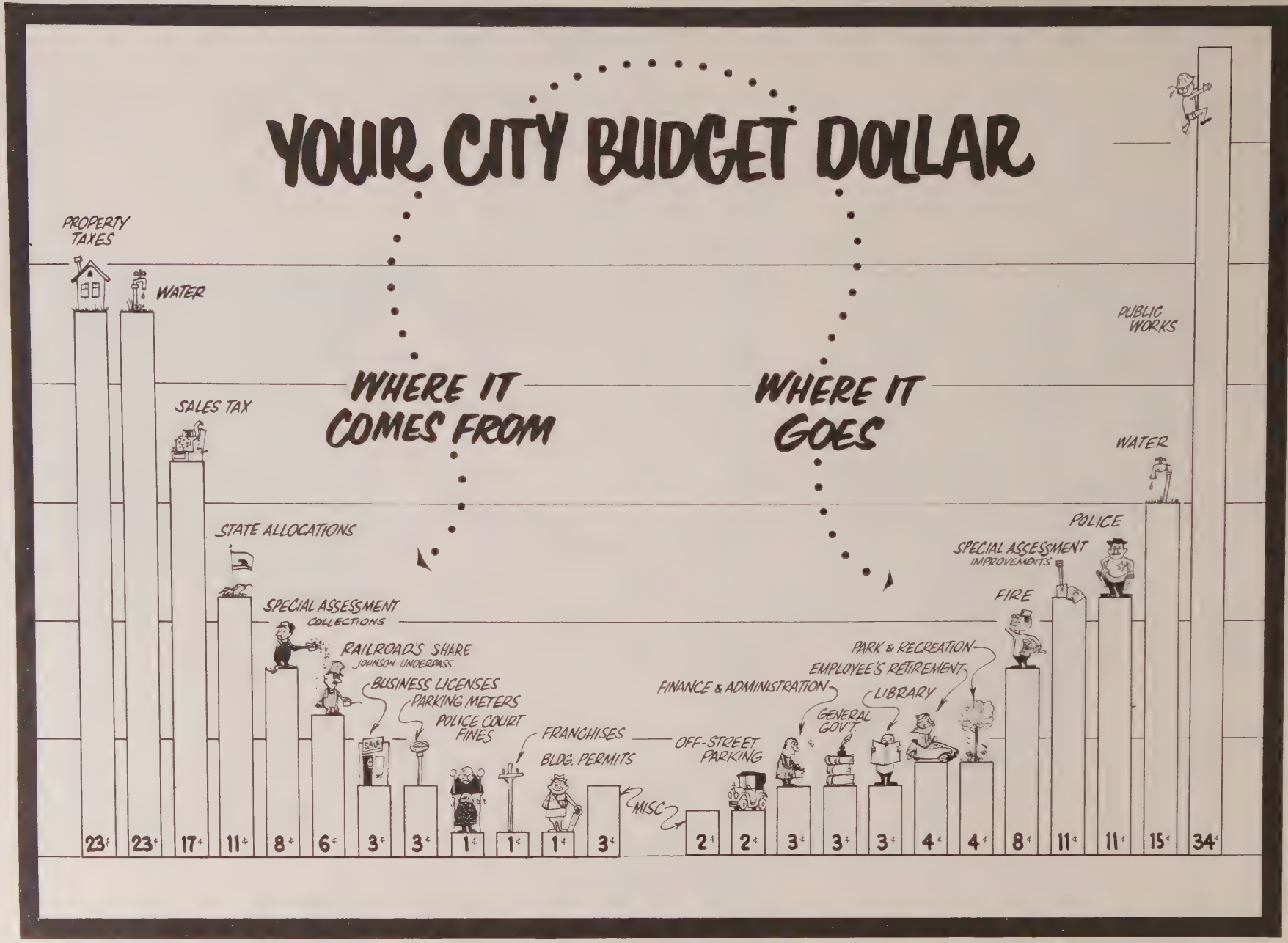
Source: Muskegon, Michigan, *Annual Report - 1952*, p. 49.

Figure 19



Source: Wichita, Kansas, *Capital Budget 1958 - 1963*.

Figure 20



Source: San Luis Obispo, California, *Official Budget 1958-59*, p. 14.

Figure 21

NUMBER OF FULL-TIME EMPLOYEES, BY DEPARTMENTS, 1950 TO PRESENT

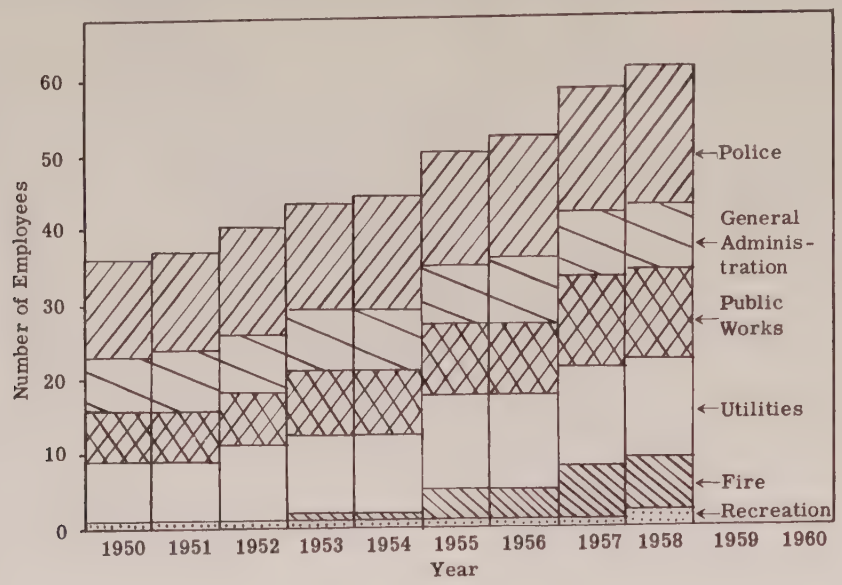


Figure 22

EXPENDITURES FOR MAJOR BUDGETARY CATEGORIES, 1950 TO PRESENT

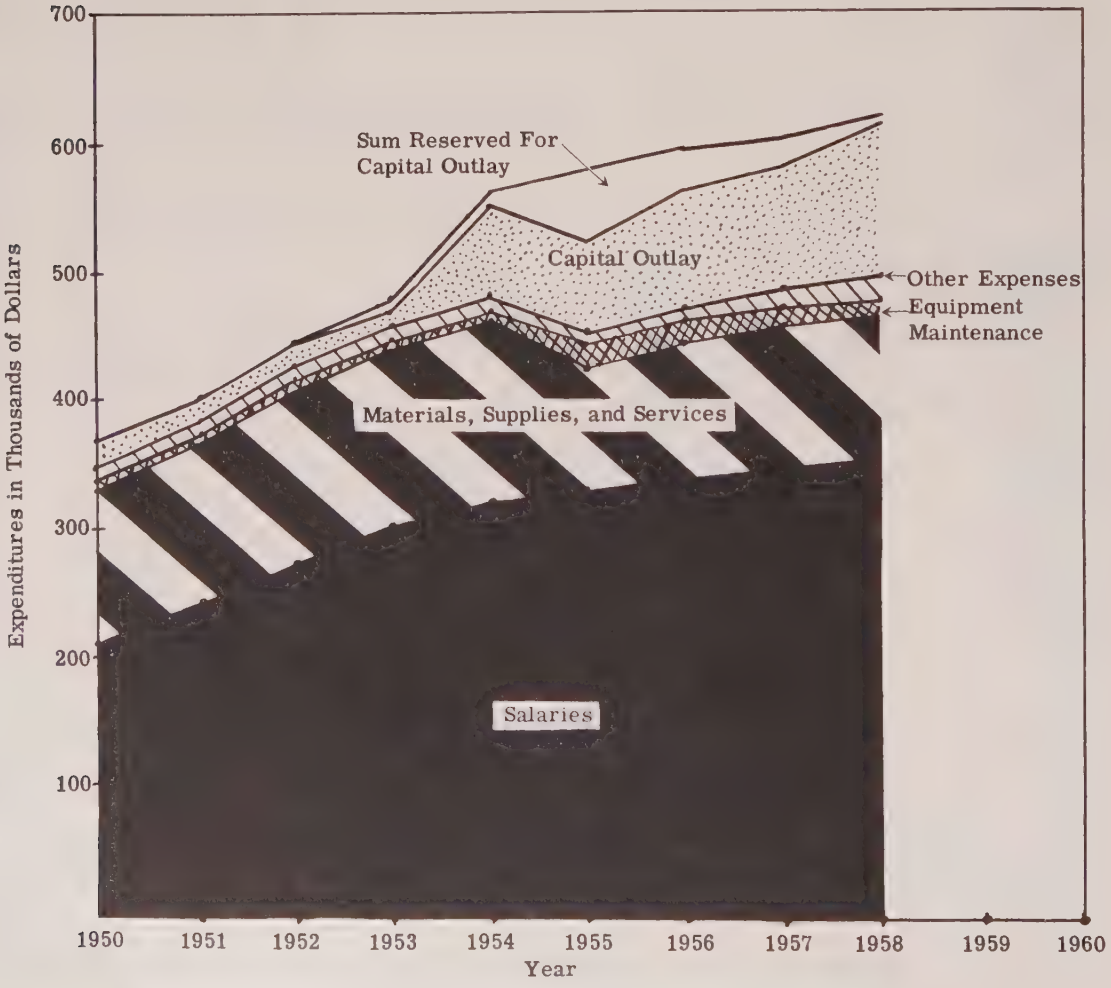
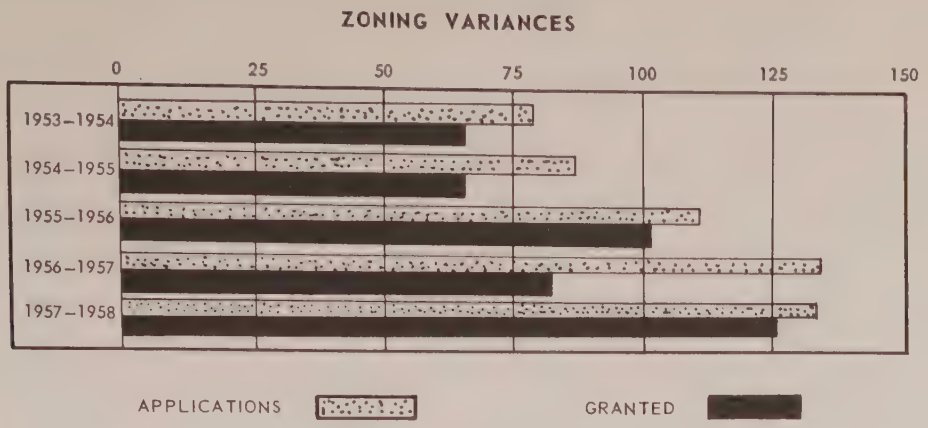


Figure 23



Source: Arlington County, Virginia, *Annual Report - 1958, Office of Planning*, p. 21.

Figure 24

CONVICTIONS AS A PERCENTAGE OF TOTAL ARRESTS

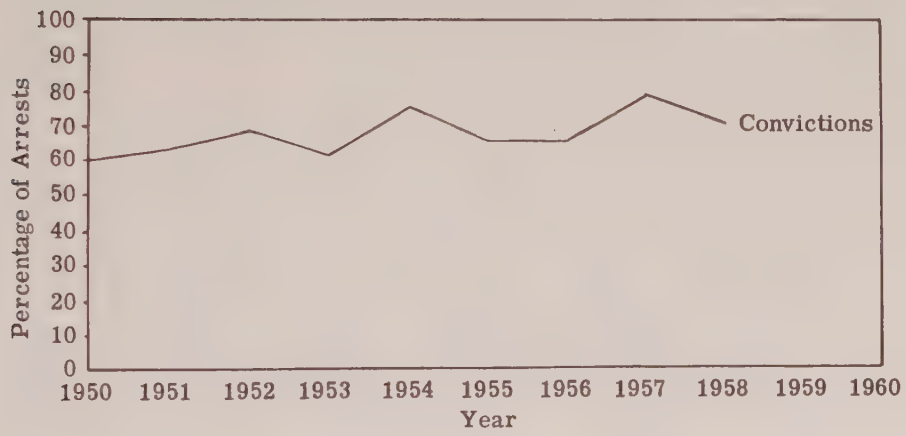


Figure 25

NUMBER OF FIRES BY MAJOR TYPES, 1950 TO PRESENT

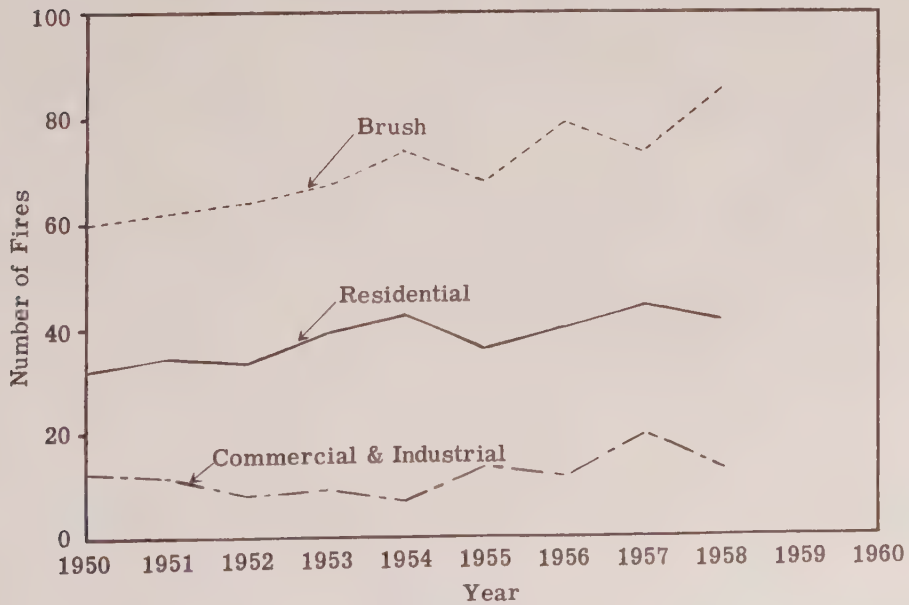


Figure 26

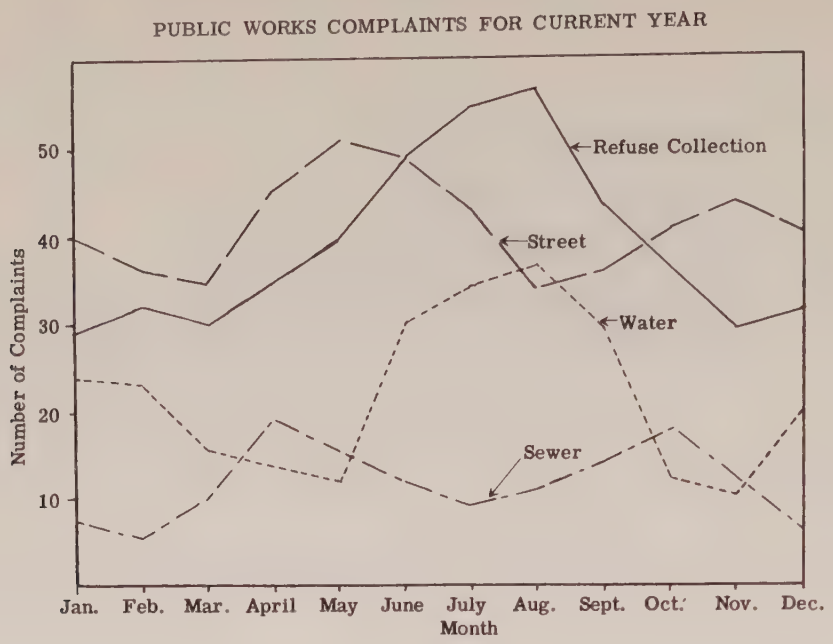
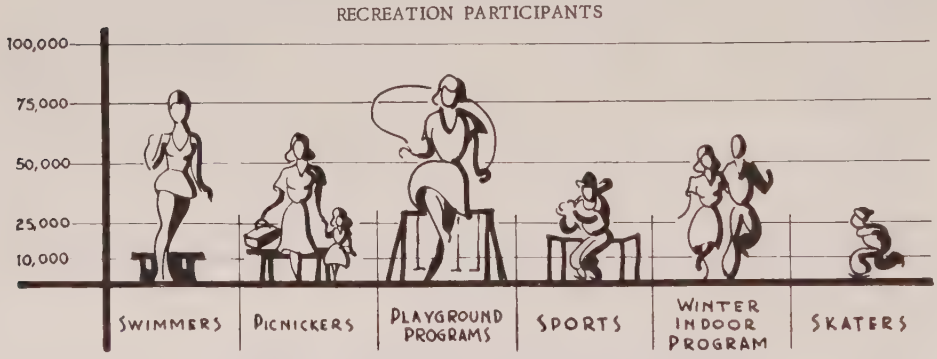


Figure 27



Source: Muskegon, Michigan, *Annual Report - 1952*, p. 31.

Figure 28

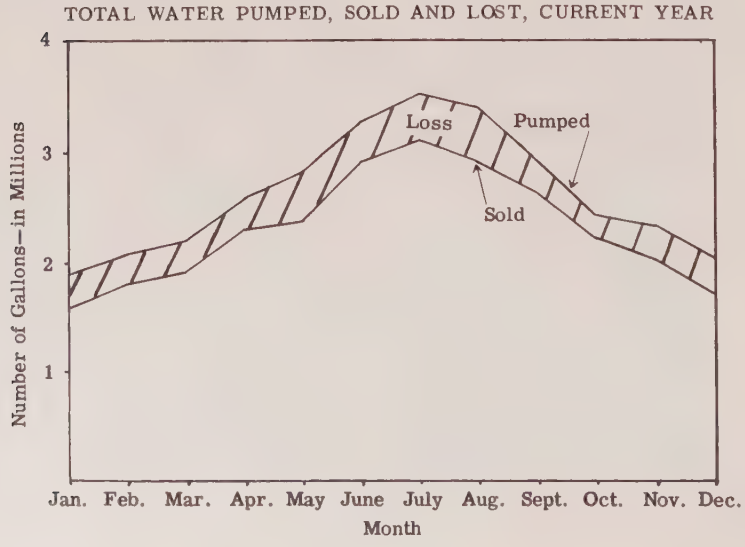
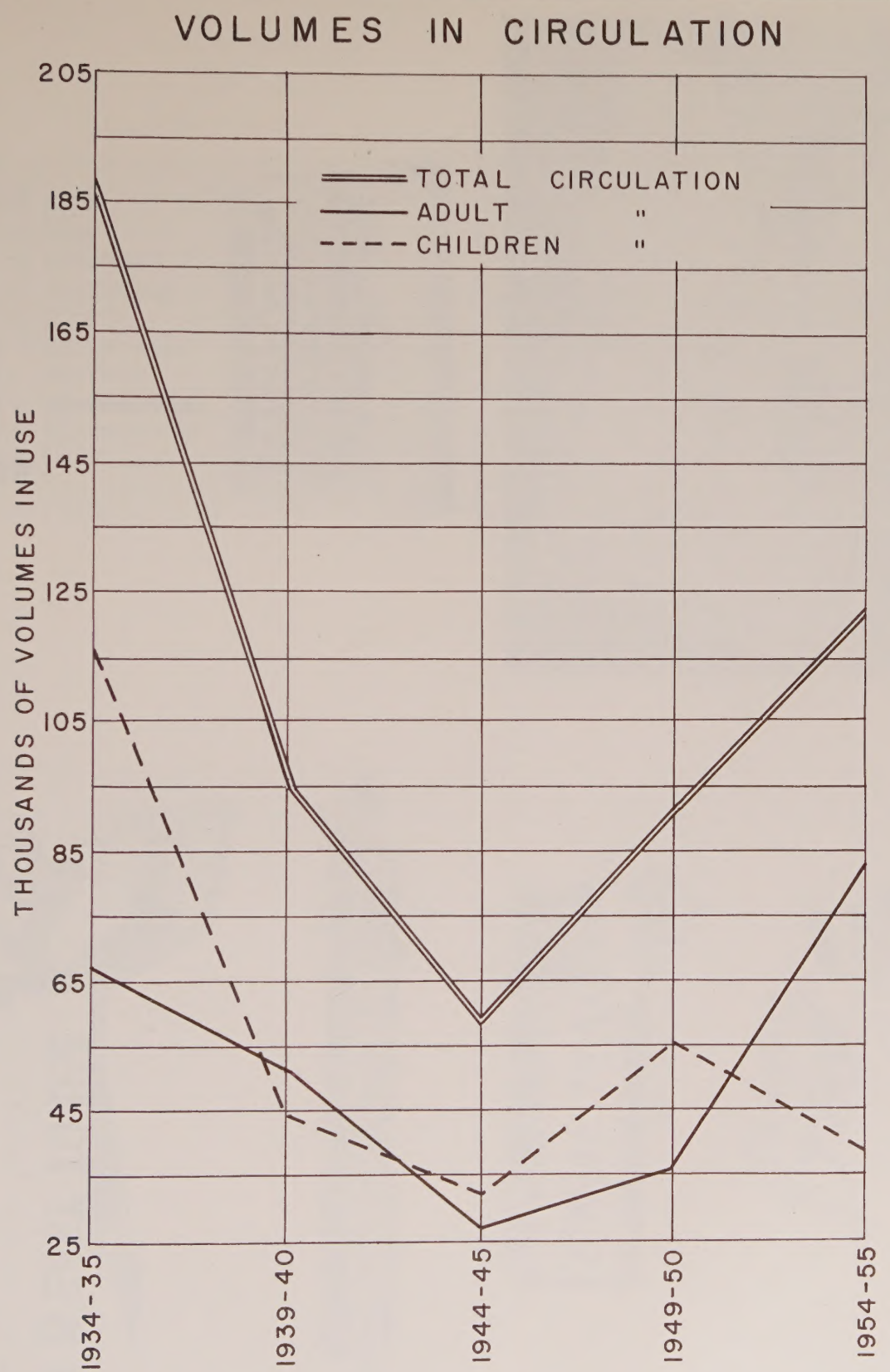


Figure 29



Source: Minot, North Dakota, *City Manager's Report, Fiscal Year 1954-1955.*

Figure 30

Figure 31. How To Use Fototype

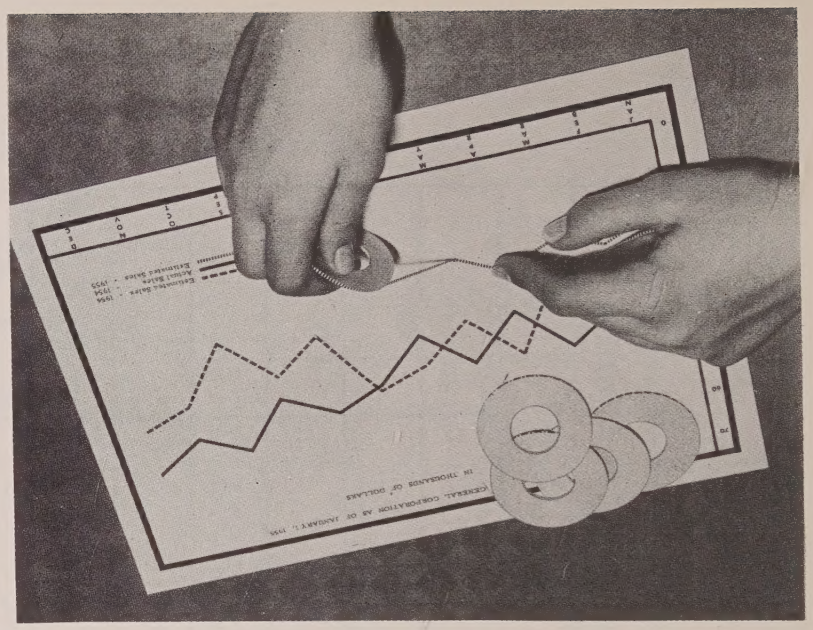


Figure 32. How To Use Chart-Pak

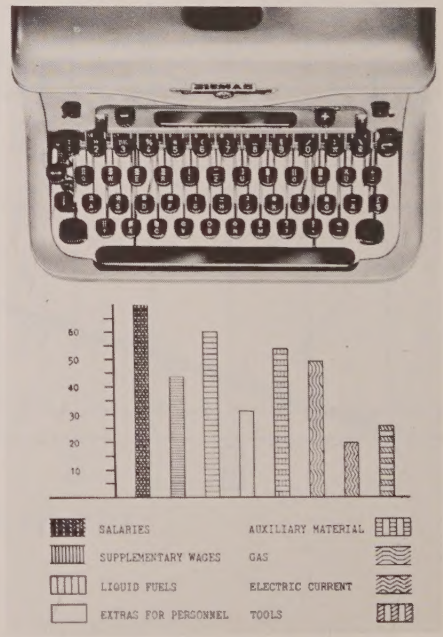


Figure 33. Chart-Typer keyboard and examples of work.